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PROFITABLE MANAGEMENT OF GENERAL FARMS IN THE WILLAMETTE VALLEY, OREGON.

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SCOPE OF THE BULLETIN.[1]

This bulletin is based on information secured from the analysis of a year's business (1912) on 212 general farms in Marion and Polk Counties, Oreg., and a general farm practice study in the Willamette Valley covering a period of several years. It presents some of the more important factors which influence the profits on the farms studied, shows why the "valley" or silt loam farms are operated more efficiently than the "red hill" or clay farms, and makes recommendations that should materially increase the profitableness of general farming throughout the Willamette Valley.

SUMMARY AND CONCLUSIONS.

Of the 212 farms embraced in this study 68 are located on the clay soil and 144 on the silt loam soil.

[1] The figures presented in this bulletin are those secured in a typical year before the war, 1912. It would be impracticable to offer recent figures, because of the unstable conditions prevailing the last few years. The prime emphasis is not to be placed on the presentation of comparative profits for one year, but on the lessons which these figures set forth. In short, it is the desire merely to indicate some of the fundamentals of farming success in the Willamette Valley, drawing upon one typical year for practical illustrations and showing the relationship between the various factors in farming.

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Some of the factors which tend to influence efficiency on these farms are: (1) The area of land in summer fallow; (2) the income per productive animal unit; (3) crop yields; and (4) the percentage of the field-crop area devoted to clover and other legumes.

Clover seed was a profitable crop in 1912. During that year over 10 per cent of the total receipts of the silt loam farms were derived from the sale of clover seed, though the crop occupied only 4.5 per cent of the rotation area.

Comparative yields and values of the cereal crops per acre strongly indicate that the area devoted to oats on both the clay and silt loam farms should be reduced, with a view to growing more profitable crops.

The farm income of the clay farms was 4.35 per cent of the capital invested, as compared with 6.64 per cent for the silt loam farms. In other words, the silt loam farms were a half more profitable than the clay farms. The clay farms grow less clover and other legumes than the silt loam farms, had a greater acreage and lower yield of oats, and had a much larger percentage of the rotation area lying idle as summer fallow.

Crop yields may be increased materially on most of the farms studied by devoting more of the tillable land to clover and other legumes. A few of the silt loam farms were probably devoting sufficient area to these crops.

That clover can be grown successfully on the clay farms is shown by the 53 trials, covering over 1,000 acres, on 83.8 per cent of which successful stands were obtained.

AGRICULTURAL HISTORY OF THE VALLEY.

Between 1850 and 1860 most of the prairie lands of the Willamette Valley were brought under cultivation. Even as early as 1844 there was a surplus wheat crop of 10,000 bushels. In the very beginning of the agricultural development of the valley, wheat became the leading crop. Oats were also an important crop, and corn was grown in a limited way. Timothy and cheat[1] were the principal hay crops. Clover was tried superficially and pronounced a failure because the first trials failed to give satisfactory stands. From the most reliable information available it appears that wheat in those early days yielded from 30 to 40 bushels per acre and oats from 50 to 75 bushels.

For a number of years the land produced a crop each year. However, the soil soon became infested with wild oats, and about 1865 the farmers began to summer fallow; that is, the land was clean cultivated once in every three or four years. Under this system of

[1] *Bromus secalinus.*

farming crop yields gradually declined. The average yield of wheat for the Willamette Valley during the early eighties was not far from 17 bushels per acre. The United States Census report shows that the average yield of wheat for Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill Counties for the year 1880 was 14.9 bushels per acre.

The practice of summer fallowing from one-fourth to one-third of the land each year and the production of wheat and oats to the exclusion of almost all other field crops has prevailed on the red hill or clay type of soil to the present time. On the silt loam or "valley" soil, on the other hand, radical changes in the type of farming have taken place. Clover and vetch were introduced during the eighties and early nineties, and the practice of summer fallowing has practically been abandoned on this type of soil. The influence of these leguminous crops on crop yields and the efficient management of these farms will be shown in the tables which follow.

TYPES OF SOIL.

The 212 farms which constitute the basis of this study are located on two distinct types of soil, Salem silt loam and Salem clay. [1] The Salem silt loam is locally known as "valley" or "prairie" soil. It occupies the level and gently rolling valley lands. The soil is a brown to black silt loam, 18 to 24 inches deep. The subsoil is a yellowish to red clay loam which becomes heavier with the depth. The Salem clay type is locally known as "red hill" soil. It occupies a series of rolling hills on either side of the "valley" or silt loam soil. The Salem clay soil consists of 12 to 15 inches of red clay, which is underlain by a clay of much the same color and texture as the surface soil.

DEFINITIONS OF TERMS USED.

Definitions of some of the terms used in this discussion may be found helpful in studying the tables which follow.

Improved land.—The usable portion of the farm. It includes the tillable area and any portion of the farm that has been improved sufficiently to furnish fairly good pasturage.

Rotation area.—That portion of the farm upon which field crops are changed about from year to year. It includes the areas in field crops, summer fallow, and pasture in rotation. It does not include the area in fruit and garden.

Field-crop area.—That portion of the farm occupied by the field crops.

[1] Salem silt loam and Salem clay are terms applied to these soils by the Bureau of Soils, U. S. Department of Agriculture, when making a soil survey in Marion and Polk Counties, 1903.

Crop index.—The yielding power of the soil of a given farm or group of farms expressed as a percentage of the average yielding power of the soil of all farms in the community.[1]

Animal unit.—A mature horse or cow, or as many smaller animals as require the feed of a horse or cow, namely, 2 head of young cattle, 2 colts, 5 hogs, 10 pigs, 7 sheep, 14 lambs, 7 goats, 14 kids, or 100 hens.

Productive animal unit.—Includes all animal units except work horses.

Receipts.—The gross income of the farms from all sources.

Expenses.—The total amount necessary to conduct the farm business during the year. It includes, besides all cash outlay, depreciation of equipment and buildings and all unpaid family labor (excepting that of the operator) used in conducting the farm business.

Farm income.—The difference between the gross receipts and the expenses. It is the amount available to the farm family for living, saving, and paying debts after the expenses of conducting the farm business during the year have been paid. It does not include what the farm furnished directly toward the family living.

Percentage farm income is of capital invested.—Farm income does not include the amount the farm furnishes the family in the way of food, fuel, and the use of the farm dwelling. Neither do the expenses include the value of the operator's labor and the cost of his board. These two amounts, that is, what the farm furnished the family and the value of the operator's labor and the cost of his board, were so nearly equal on the farms studied that percentage farm income is of capital invested is used in this discussion to measure the efficiency of farming.

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[1] The crop index may be defined as the crop yields of a particular farm expressed in percentage of the average crop yields of all the farms in the community. It is found as in the following example:

A particular farm produces—

2,000 bushels of corn on	40 acres,
1,200 bushels of wheat on	40 acres,
900 bushels of oats on	30 acres, and
120 tons of hay on	80 acres.
Total.....	190

The average yields of the above crops in the community are: Corn, 60 bushels; wheat, 32 bushels; oats, 40 bushels; and hay, 1¾ tons per acre. Hence, on the average, the areas required to produce the above quantities of the products mentioned are—

2,000÷60=	33.3 acres of corn,
1,200÷32=	37.5 acres of wheat,
900÷40=	22.5 acres of oats, and
120÷1¾=	68.6 acres of hay.
Total=	161.9

Thus, it requires 190 acres on the farm in question to produce what 161.9 acres produces on the average. Hence, 1 acre produces on this farm 161.9÷190, or 85.3 per cent as much as the average acre of the community.

USE AND VALUE OF LAND.

The comparative size of farm, value of real estate per acre, and the use made of the farm area on the two types of soil are shown in Table I.

TABLE I.—*Relation of type of soil to use and value of land on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Use and value of land.	Salem clay.	Salem silt loam.
Number of farms	68	144
Average size of farm (acres)	260	175
Value of real estate per acre	$89	$112
Percentage of farm area in—		
Improved land	71.2	73.6
Tillable land	67.9	70.9
Rotation	63.7	65.3
Field crops	46.7	62.2
Pasture	26.7	27.8
Summer fallow	15.6	1.8
Fruit and garden	1.5	1.0
Woodland	24.9	22.7
Waste land	3.9	3.7

It will be seen that the 68 clay farms averaged 85 acres larger and had a real-estate value $23 per acre less than the silt loam farms. There was 2.4 per cent more of the farm area in improved or usable land and 13.8 per cent less of the farm area lying idle as summer fallow on the silt loam farms than on the clay farms. The relation of these differences to the comparative efficiency of farming on the two types of soil will be indicated elsewhere.

USE OF CAPITAL.

The average investment and the use made of capital on the 212 farms are shown in Table II. The clay farms had an average of $3,873 more capital than the silt loam farms, and the silt loam farms had 0.6 per cent more of the total capital invested in working capital than the clay farms.

TABLE II.—*Use of capital on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Use of capital.	Salem clay.	Salem silt loam.
Number of farms	68	144
Investment per farm	$25,330	$21,457
Percentage of investment on—		
Real estate	91.6	91.0
Implements and machinery	1.9	2.2
Live stock	5.9	6.2
Feed and supplies	.1	.1
Cash to run farm	.6	.5
Working capital	8.4	9.0

TYPES OF FARMING.

The number of farm records obtained in the survey made in Marion and Polk Counties in 1912 is not sufficient to justify comparisons of the many types of farming to be found in the Willamette Valley. For this reason all of the records of the survey except 212, those representing general or mixed farming, were discarded. The types of farming practiced on these 212 farms will be considered from the standpoint of the use made of the rotation area, the live stock kept, and the sources of income.

RELATION OF THE ROTATION AREA TO TYPE OF FARMING.

Figure 1 represents graphically the use made of the rotation area on the two types of soil. Oats, it will be seen, were the most promi-

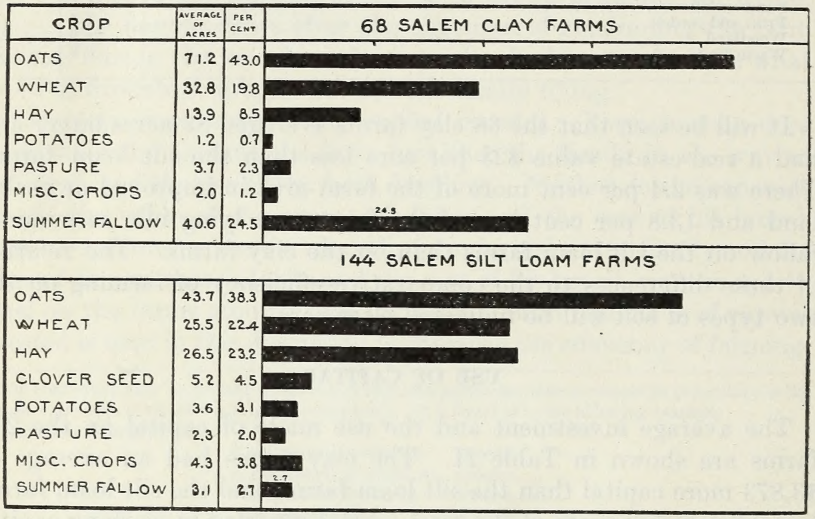

FIG. 1.—Utilization of rotation area on 212 farms in Marion and Polk Counties, Oreg. (1912).

nent crop grown, and oats and wheat occupy relatively about the same percentage of the rotation area on the clay farms as on the silt loam farms. The types of farming followed on the two soils differ materially in the percentage of the rotation area devoted to clover seed, hay, and summer fallow. The prominence of the oat crop and the difference in the uses made of the rotation, it will be seen later, have considerable influence on the comparative profitableness of farming on the two soils.

RELATION OF LIVE STOCK TO TYPE OF FARMING.

Figure 2 shows the number of animal units kept per 100 acres of improved land, and the number of animals of each kind kept per farm. It will be seen that dairy cows were the most important

productive animals kept on these farms. Work horses, it must be remembered, are not considered productive animals. Sheep stood second in importance on the clay farms, and hogs on the silt loam farms. The clay farms kept relatively less stock than the silt loam

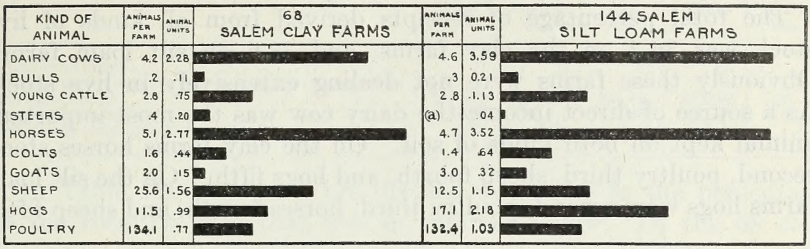
KIND OF ANIMAL
ANIMALS PER FARM
ANIMAL UNITS
68 SALEM CLAY FARMS
ANIMALS PER FARM
ANIMAL UNITS
144 SALEM SILT LOAM FARMS
DAIRY COWS 4.2 2.28 4.6 3.59
BULLS .2 .11 .3 0.21
YOUNG CATTLE 2.8 .75 2.8 1.13
STEERS .4 .20 (a) .04
HORSES 5.1 2.77 4.7 3.52
COLTS 1.6 .44 1.4 .64
GOATS 2.0 .15 3.0 .32
SHEEP 25.6 1.56 12.5 1.15
HOGS 11.5 .99 17.1 2.18
POULTRY 134.1 .77 132.4 1.03

FIG. 2.—Number of animal units per 100 acres of improved land and number of animals per farm on 212 farms in Marion and Polk Counties, Oreg. (1912).

farms. The total animal units kept per 100 acres of improved land on the clay farms were 10.02, as compared with 13.77 on the silt loam farms. These are very low complements of live stock. In other words, live stock on these farms was kept as a side line to cash-crop farming.

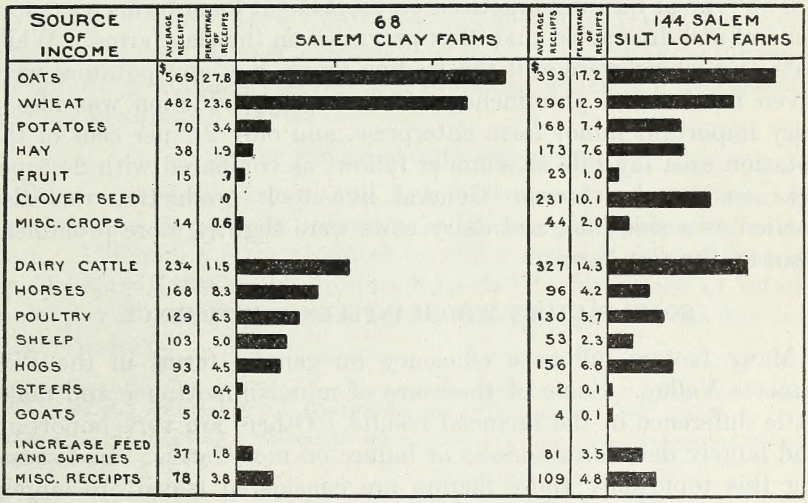
SOURCE OF INCOME
AVERAGE RECEIPTS
PERCENTAGE OF RECEIPTS
68 SALEM CLAY FARMS
AVERAGE RECEIPTS
PERCENTAGE OF RECEIPTS
144 SALEM SILT LOAM FARMS
OATS $569 27.8 $393 17.2
WHEAT 482 23.6 296 12.9
POTATOES 70 3.4 168 7.4
HAY 38 1.9 173 7.6
FRUIT 15 .7 23 1.0
CLOVER SEED .0 231 10.1
MISC. CROPS 14 0.6 44 2.0
DAIRY CATTLE 234 11.5 327 14.3
HORSES 168 8.3 96 4.2
POULTRY 129 6.3 130 5.7
SHEEP 103 5.0 53 2.3
HOGS 93 4.5 156 6.8
STEERS 8 0.4 2 0.1
GOATS 5 0.2 4 0.1
INCREASE FEED AND SUPPLIES 37 1.8 81 3.5
MISC. RECEIPTS 78 3.8 109 4.8

FIG. 3.—Percentage of receipts and amounts received from different sources on 212 farms in Marion and Polk Counties, Oreg. (1912).

RELATION OF SOURCES OF INCOME TO TYPE OF FARMING.

The percentage of receipts from different sources for the two types of soil are shown in figure 3. The clay farms received 58.2 per cent of their receipts from the sale of crops, and the silt loam farms 58.1 per cent. The clay farms, it will be observed, received practically

all of their crop receipts from the sale of oats and wheat. While oats and wheat lead on the silt loam farms also, 10.1 per cent of the total receipts were from clover seed, 7.6 per cent from hay, and 7.4 per cent from potatoes. It will thus be seen that the silt loam farms had receipts from a much greater variety of crops.

The total percentage of receipts derived from all kinds of live stock was 36.2 on the clay farms, and 33.6 on silt loam farms. Obviously these farms were not dealing extensively in live stock. As a source of direct income the dairy cow was the most important animal kept on both kinds of soil. On the clay farms horses stood second, poultry third, sheep fourth, and hogs fifth. On the silt loam farms hogs were second, poultry third, horses fourth, and sheep fifth.

CLAY AND SILT LOAM TYPES OF FARMING CONTRASTED.

It will be seen, therefore, that the type of farming practiced on the 68 clay farms during the year 1912 was that of grain farming under a system of summer fallowing approximately one-fourth of the rotation area each year. Oats occupied more than twice as much land as wheat, and oats, wheat, and summer fallow occupied 87.3 per cent of the rotation area. General live stock were kept as a side line, dairy cows being the most important productive animals.

The type of farming practiced on the 144 silt loam farms was more general and diversified than that practiced on the clay farms. While oats and wheat were still the leading crops, hay and potatoes were given much more prominence. Clover-seed production was also a very important minor farm enterprise, and only 2.7 per cent of the rotation area lay idle as summer fallow, as compared with 24.5 per cent on the clay farms. General live-stock production was also carried as a side line, and dairy cows were slightly more prominent than on the clay farms.

SOME FACTORS WHICH INFLUENCE EFFICIENCY.

Many factors influence efficiency on general farms in the Willamette Valley. Some of these are of minor importance and make little difference in the financial results. Others are very important and largely determine success or failure on most farms. In discussing this topic only those factors are considered which are largely within the control of the farmer and which stand out prominently as contributing to the profit or loss of these farms.

SUMMER FALLOW.

From 40 to 50 years ago the practice of summer fallowing the land once every three or four years was universally followed in the Willamette Valley. While the practice still prevails on the clay farms, it has practically disappeared on the silt loam farms.

TABLE III.—*Relation of summer fallow to percentage farm income is of capital on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Item.	Rotation area in summer fallow.				
	On Salem clay.			On Salem silt loam.	
	None.	25 per cent or less.	Over 25 per cent.	None.	50 per cent or less.
Number of farms	11	29	28	127	17
Average percentage of rotation area in summer fallow	0	17.6	33.9	0	18.8
Average capital	$11,783	$27,030	$28,891	$20,936	$25,532
Average farm income	$687	$1,375	$985	$1,471	$1,081
Percentage farm income is of capital	5.83	5.09	3.41	7.02	4.23

In Table III the farms are divided according to the percentage of the rotation area that was in summer fallow. Of the 68 clay farms, 11 had no summer fallow, 29 had 25 per cent or less, and 28 had over 25 per cent of the rotation area in summer fallow. Of the 144 silt loam farms, 127 had no summer fallow and 17 had more or less summer fallow. Using as a measure the percentage farm income is of the capital, it will be seen that the groups of farms having no summer fallow were operated most efficiently. By dividing 5.83 by 3.41 it will be seen that the clay farms having no summer fallow were 1.71 times as efficient as those having over 25 per cent of the rotation area in summer fallow. Likewise the silt loam farms having no summer fallow were 1.66 times as efficient as the farms having summer fallow. Hence, efficiency on these farms may be increased by adopting cropping systems and rotations which will decrease the acreage in summer fallow.

INCOME PER PRODUCTIVE ANIMAL UNIT.

Where crops are grown and fed to live stock on the farm, few factors have as great an influence as income per productive animal unit. Although a farm produces excellent crops, it may still be low in efficiency if the crops produced are fed to live stock of inferior quality or if poor judgment is used in marketing live stock and live-stock products.

TABLE IV.—*Relation of income per productive animal unit to percentage farm income is of capital on 212 farms in Marion and Polk Counties, Oreg. (1912).*

[Farms on the two types of soil divided into three groups, according to income per productive animal unit.]

Item.	Income per productive animal unit.					
	On Salem clay.			On Salem silt loam.		
	Less than $44.	$44 to $62.	Over $62.	Less than $44.	$44 to $62.	Over $62.
Number of farms	26	20	22	47	47	50
Average income per productive animal unit	$29	$50	$77	$29	$53	$82
Average capital	$25,739	$27,841	$22,564	$21,090	$20,118	$23,060
Average farm income	$738	$1,154	$1,488	$931	$1,248	$2,056
Percentage farm income is of capital	2.87	4.15	6.60	4.41	6.21	8.92
Crop index	96	102	102	89	106	110

From Table IV it will be seen that farm income was 6.6 per cent of the capital invested in the group of clay farms having an income of $77 per productive animal unit as compared with 2.87 per cent in the group of farms having but $29 income per productive animal unit. Likewise the group of silt loam farms having an average income of $82 per productive animal unit made 8.92 per cent as compared with 4.41 per cent for the group having but $29 income per productive animal unit. Evidently, farm efficiency on both the clay and silt loam soils was greater where the income per productive animal unit was greater.

Securing a high income per productive animal unit in the main involves (1) the use of farm animals as scavengers to consume all feed that would otherwise go to waste; (2) economical and efficient feeding; (3) the breeding up of animals which will sell well and use feed economically; and (4) the use of good business judgment in marketing.

The variation in the percentage farm income is of capital in the different groups of farms in Table IV was partly due to a variation in crop yields, for it will be seen that the groups of farms having the highest income per productive animal unit also had the highest crop index. Especially is this true with the groups of silt loam farms where the crop index varies from 89 in the group of farms receiving $29 per productive animal unit to 110 in the group receiving $82 per productive animal unit. On the clay soil the influence of crop yields was not so prominent, since the variation in crop index only ranged from 96 in the group of farms receiving $29 per productive animal unit to 102 in the group receiving $77 per productive animal unit.

CROP YIELDS.

In Table V the farms are divided into groups according to crop index. The crop index of the clay farms is based entirely upon the 68 clay farm records. Likewise, the crop index of the silt loam farms is based only upon the 144 silt loam farm records.

TABLE V.—*Relation of crop yields to percentage farm income is of capital on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Item.	Salem clay.			Silt loam.		
	Crop index 91 and less.	Crop index 92 to 106.	Crop index 107 and over.	Crop index 89 and less.	Crop index 90 to 109.	Crop index 110 and over.
Number of farms	23	23	22	43	50	51
Average crop index	79	99	118	76	101	124
Income per productive animal unit	$40	$55	$59	$43	$55	$66
Capital (average)	$24,764	$22,021	$28,472	$21,630	$21,798	$20,975
Farm income (average)	$653	$1,085	$1,596	$746	$1,485	$1,940
Percentage farm income is of capital	2.64	4.93	5.61	3.44	6.81	9.25

The crop indexes of the three groups of clay farms were 79, 99, and 118. The percentage that farm income was of the capital for these three groups of farms was 2.64, 4.93, and 5.61, respectively. It will be observed that the percentage for the group of 22 farms with an average crop index of 118 was 2.12 times as great as that for the group of 23 farms whose crop index averaged 79. The influence of crop yield on efficiency was even more pronounced on the silt loam farms. The crop indexes of the three groups of silt loam farms were 76, 101, and 124, while the percentage that farm income was of capital for these three groups was 3.44, 6.81, and 9.25, respectively. In other words, the group of 51 farms with an average crop index of 124 was 2.69 times as efficient as the group of 43 farms with an average crop index of 76.

The difference in the percentage farm income is of capital in the different groups of farms in Table V is the result of the combined influence of crop yield and income per animal unit; for, as the table shows, those farmers whose yields were highest also obtained, on the average, the highest income per animal unit. Tabulations not given here show that of the difference between the farm incomes of the lowest and those of the highest groups, from $250 to $300 is due to difference in income per animal unit. Most of the remainder is due to difference in yield.

PERCENTAGE OF FIELD-CROP AREA IN LEGUMES.

The field-crop area is that portion of the farm upon which crops were grown during 1912, the year the farm survey was made. During that year a very limited area was devoted to leguminous crops on the clay farms. For that reason Tables VI, VII, and VIII deal only with the 144 silt-loam farms. In Table VI the farms are divided according to the percentage of the field-crop area in legumes—i. e., in clover, alfalfa, peas, and beans.

TABLE VI.—*Relation of percentage of field-crop area in legumes to percentage farm income is of capital on 144 silt loam farms in Marion and Polk Counties, Oreg. (1912).*

Item.	Per cent of field crop area in legumes—			
	None.	Under 18.	18 to 33.	Over 33.
Number of farms	35	37	37	35
Average percentage of field-crop area in legumes		12.0	26.0	44.8
Average improved land (acres)	112	133	139	121
Average capital	$19,821	$23,368	$23,272	$19,181
Average farm income	$770	$1,425	$1,834	$1,648
Percentage farm income is of capital	3.89	6.10	7.88	8.60

Of the 144 farms in Table VI, 35 grew no legumes. There were 37 farms with an average of 12 per cent, 31 with an average of 26 per cent, and 35 with an average of 44.8 per cent of the field-crop area in legumes. The percentage farm income is of capital for these groups of farms was 3.89, 6.10, 7.88, and 8.60, respectively. It will be seen

that the group of farms having an average of 44.8 per cent of the field-crop area in legumes was operated 2.21 times as efficiently as the group of farms that grew no legumes.

PERCENTAGE OF FIELD-CROP AREA IN CLOVER.

Table VI shows the influence of all legumes collectively on the returns of the silt-loam farms. Table VII is confined to a single legume—clover. Of the legumes grown on these farms, clover is by far the most important, with vetch occupying second place.

TABLE VII.—*Relation of percentage of field-crop area in clover to percentage farm income is of capital on 144 silt loam farms in Marion and Polk Counties, Oreg. (1912).*

Item.	All farms.	None.	Per cent of field-crop area in clover—	
			Less than 20.	20 or more.
Number of farms	144	61	45	38
Average per cent of field-crop area in clover	12.0		11.1	32.7
Average capital	$21,457	$20,228	$23,192	$21,372
Average farm income	$1,425	$1,026	$1,614	$1,843
Percentage farm income is of capital	6.64	5.06	6.96	8.63

The importance of the clover crop is shown in Table VII. Of the 144 farms, 61 grew no clover in 1912. Forty-five farms had an average of 11.1 per cent, and 38 farms had an average of 32.7 per cent of the field-crop area in clover. The average farm incomes of these three groups of farms were 5.06, 6.96, and 8.63 per cent, respectively, of the capital invested. The 38 farms having an average of 32.7 per cent of the field-crop area in clover were 1.71 times as efficient as those having no clover.

CLOVER-SEED PRODUCTION.

Table VIII shows that clover seed was a very profitable crop in the Willamette Valley in 1912. The average yield per acre on the 54 farms that produced clover seed was 286 pounds for the first crop and 108 pounds for the second crop. The average price received for clover seed was 14.67 cents. The yields and prices are averages for both red and alsike clover for the year 1912.

TABLE VIII.—*Relation of clover-seed production to percentage farm income is of capital on 144 silt loam farms in Marion and Polk Counties, Oreg. (1912).*

Item.	None.	Per cent of receipts from clover seed—	
		Less than 14.	14 or more.
Number of farms	90	28	26
Average percentage of receipts from clover seed		6.8	32.4
Average capital	$19,900	$21,971	$26,291
Average farm income	$1,075	$1,709	$2,332
Percentage farm income is of capital	5.40	7.78	8.87

There were 90 farms on which no clover seed was sold. On 28 farms 6.8 per cent, and on 26 farms 32.4 per cent, of the receipts were from the sale of clover seed. The average farm incomes of these three groups were, respectively, 5.40, 7.78, and 8.87 of the capital invested. Thus 26 farms which received an average of 32.4 per cent of their receipts from the sale of clover seed were 1.64 times as efficient as the 90 farms that sold no clover seed.

CHOICE OF CEREAL CROPS.

Table IX shows the comparative value and yield of oats, wheat, barley, and corn per acre in the Willamette Valley. The yields per acre are averages computed from the United States Census Reports for the years 1880, 1890, 1899, and 1909. The values per acre are based upon the average prices of these crops at Portland, Oreg., for the 10-year period, 1906 to 1915, inclusive. The price of barley is used in computing the value of corn, it being assumed that these two crops are approximately equal in value, pound for pound.

TABLE IX.—*Comparative value and yield of oats, wheat, barley, and corn per acre for the nine counties of the Willamette Valley, Oreg. (U. S. Census Reports 1880, 1890, 1899, 1909).*

Yield and value per acre.	Oats.	Wheat.	Barley.	Corn.
Yield per acre:				
Bushels	28.5	18.9	26.8	26.9
Pounds	912	1,134	1,286	1,506
Value per acre	$12.14	$16.53	$16.15	$18.92

From the standpoint of value as stock feed, 912 pounds of oats are not to be compared with 1,134 pounds of wheat, 1,286 pounds of barley, or 1,506 pounds of corn. It will also be seen that there is a marked difference in the cash value of these crops, oats being worth $12.14, wheat $16.53, barley $16.15, and corn $18.92 per acre.

TABLE X.—*Comparative value and yield of oats, wheat, and barley per acre on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Yield and value per acre.	Salem clay (68 farms).		Salem silt loam (144 farms).		
	Oats.	Wheat.	Oats.	Wheat.	Barley.
Yield per acre:					
Bushels	30.8	25.2	37.7	22.0	36.6
Pounds	986	1,512	1,206	1,320	1,757
Value per acre	$13.12	$22.02	$16.05	$19.23	$22.06

Table X shows the comparative value and yield per acre of oats and wheat on the 68 clay farms, and of oats, wheat, and barley on the 144 silt loam farms for the year 1912. The values per acre in this table are also based on the average prices at Portland, Oreg., for 10 years. Of the 68 clay farms, only one reported barley, and barley is therefore not considered under the clay type of soil.

It will be seen that the average yield of wheat on the clay farms was 526 pounds per acre greater than the yield of oats; also that the wheat crop was worth $8.90 per acre more than the oat crop. Differently stated, the wheat crop was worth 1.68 times as much per acre as the oat crop. On the silt loam farms, according to Table X, the yield of oats per acre was 114 pounds and 551 pounds, respectively, below the yield of wheat and barley. Likewise, the cash value of the oat crop per acre was $3.18 and $6.01, respectively, below the value of the wheat and barley crops.

If Tables IX and X represent even approximately the comparative values and yields per acre of oats, wheat, barley, and corn, the profitableness of general farming in the Willamette Valley may be increased greatly by a readjustment of the acreage devoted to these crops. Since oats occupied 43 per cent and wheat but 19.8 per cent of the rotation area on the clay farms, it would appear from a study of Table X that oats should largely be replaced by wheat or some other more profitable crop. It should be remembered, however, that most of the wheat crop of the clay farms was grown upon land that had been summer fallowed the previous year, while little or none of the oat crop was grown on summer-fallowed land.

On the silt loam farms studied in 1912 oats occupied 38.8 per cent of the rotation area. This was nearly twice the area occupied by any other crop. A study of Tables IX and X seems to indicate also that much of the oat crop on the silt loam farms can be replaced profitably by other crops. While Table IX shows that corn is the most profitable of the cereal crops, the moist fall and winter climatic conditions of the Willamette Valley practically limit its production to what can be used on the farm. Owing to its superior yield corn should be grown much more extensively, especially for silage and fall and early winter feeding. It will be claimed by some that much of the oat crop is produced on land that will not raise good barley. While there may be some merit to this claim, most Willamette Valley soils produce good yields of barley. Since barley is the equal of oats, pound for pound, as a general stock feed, and since our present knowledge indicates that there is a marked difference in the yield of the two crops, it appears that the acreage of oats should be cut down and that barley should be grown more extensively.

SOME FACTORS WHICH INFLUENCE CROP YIELDS.

Table V shows that the percentage farm income of capital was highest in the group of farms having the highest average crop yields. Any means whereby crop yields may be increased, therefore, should be highly important. The following discussion deals with a few of the more practical ways of increasing crop yields.

RELATION OF LEGUMINOUS CROPS TO CROP YIELDS.

Table VI shows that the group of silt loam farms having the greatest percentage of the field crop area in legumes was operated most efficiently. Apparently, therefore, the legumes were profitable crops. Aside from being profitable crops themselves, legumes also affect the yields of other crops. Table XI shows the influence of leguminous crops on the yields of potatoes, wheat, oats, and hay on the 144 silt loam farms in 1912.

TABLE XI.—*Relation of percentage of field-crop area in legumes to crop yields on 144 farms on silt loam soil, Marion and Polk Counties, Oreg. (1912).*

Item.	All farms.	No legumes.	Per cent of field crop area in legumes.		
			Under 18.	18 to 33.	Over 33.
Number of farms	144	35	37	37	35
Average percentage of field-crop area in legumes	20.4	.....	12.0	26.0	44.8
Crop yields per acre:					
Potatoes (bushels)	150.2	132.8	145.5	172.0	183.5
Wheat (bushels)	22.0	18.8	21.5	23.8	23.7
Oats (bushels)	37.7	28.5	38.3	40.9	44.5
Hay (tons)	1.94	1.82	2.00	1.86	2.07
Crop index	100	83	100	105	111

There were 35 farms that grew no legumes, 37 that had an average of 12 per cent, 37 that had an average of 26 per cent, and 35 that had an average of 44.8 per cent of the field-crop area in leguminous crops. The yields of potatoes and oats increased steadily, though not in the same ratio, as the percentage of the field-crop area in legumes increased; the yield of wheat of each of the three groups of farms growing legumes was considerably higher than that of the 35 farms having no legumes; and the groups of farms growing legumes had slightly higher yields of hay than did the group having no legumes. Crop index, it will be observed, varied from 83 for the group of farms having no legumes to 111 for the group having an average of 44.8 per cent of the field-crop area in legumes.

Figure 4 is a graphical representation of the percentage of increase in the yields of potatoes, wheat, and oats for the three groups of farms of Table XI which grew legumes, as compared with the yields of these crops for the group of farms having no legumes. It will be seen that the percentage of increase in the yields of potatoes and oats advanced steadily from group to group, although not proportionally, as the percentage of field-crop area in legumes increased; and that the percentage of increase in the yield of wheat advanced in the two groups of farms having an average of 12 and 26 per cent of the field-crop area in legumes and then declined one-half per cent in the next group. The yields of wheat, potatoes, and oats for the group of farms having an average of 44.8 per cent of the field-crop area in legumes were 26, 38, and 56 per cent greater, respectively, than the yields of these crops for the group of farms that grew no legumes.

RELATION OF CLOVER TO CROP YIELDS.

Of the leguminous crops grown on the silt loam farms, clover was by far the most important, with vetch second. In Table XII the farms are arranged in groups according to the percentage of the field-crop area devoted to clover.

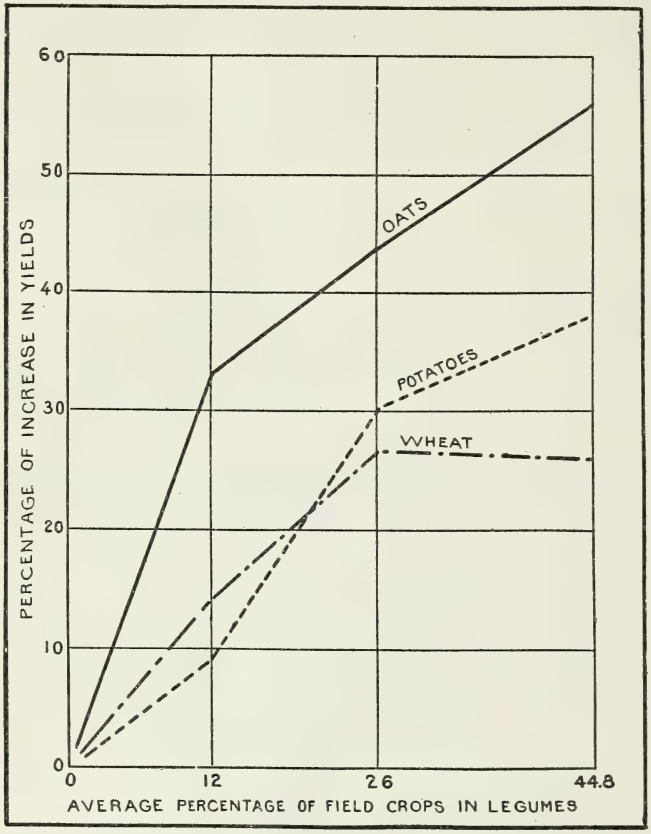

FIG. 4.—Percentage of increase in crop yields with increase in percentage of field crop area in legumes on 144 silt loam farms in Marion and Polk Counties, Oreg. (1912).

TABLE XII.—*Relation of percentage of field-crop area in clover to crop yields on 144 silt loam soil farms, Marion and Polk Counties, Oreg. (1912).*

Item.	All farms.	Per cent of field-crop area in clover.		
		No clover.	Less than 20.	20 or more.
Number of farms	144	61	45	38
Average per cent of field-crop area in clover	12.0	.....	11.1	32.7
Crop yields per acre:				
Potatoes (bushels)	150.2	140.4	159.0	163.7
Wheat (bushels)	22.0	20.5	22.1	24.9
Oats (bushels)	37.7	34.1	38.2	45.5
Hay (tons)	1.94	1.82	2.00	2.05
Crop index	100	92	102	113

On 61 farms no clover was grown; 45 farms devoted less than 20 per cent and 38 farms over 20 per cent of the field-crop area to clover. It will be observed from this table that the yields of potatoes, wheat, and oats steadily increased when the percentage of the field-crop area in clover increased. The yield of hay, also, was approximately one-fourth of a ton per acre greater on farms growing clover than on those having no clover. The crop index ranged from 92 for the group of

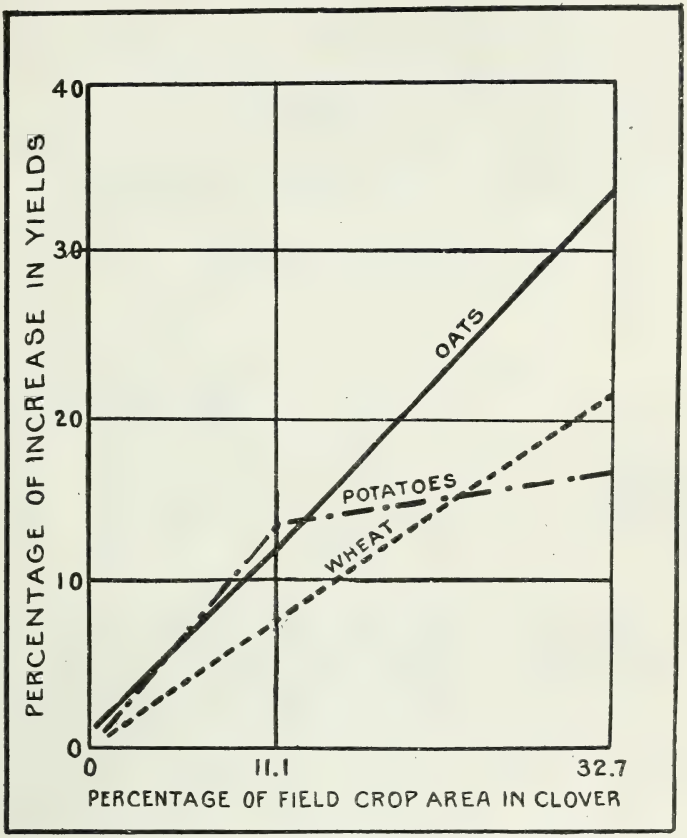

FIG. 5.—Percentage of increase in crop yields with increase in field-crop area in clover on 144 silt loam farms in Marion and Polk Counties, Oreg. (1912).

farms that grew no clover to 113 for the group having over 20 per cent of the field-crop area in clover.

Figure 5 shows the percentage of increase in the yields of potatoes, wheat, and oats for the two groups of farms in Table XII which grew clover, as compared with the yields of these crops for the group of 61 farms having no clover. The average yields of wheat, potatoes, and oats for the group of 45 farms having 11.1 per cent of the field-crop area in clover were 8 per cent, 13 per cent, and 12 per cent higher, respectively, than the yields of these crops for the group of 61 farms

having no clover. Likewise the average yields of potatoes, wheat, and oats for the group of 38 farms having an average of 32.7 per cent of the field-crop area in clover were 17 per cent, 21 per cent, and 33 per cent higher than the yields of these crops for the group having no clover.

RELATION OF SUMMER FALLOW TO CROP YIELDS.

In considering the influence of summer fallow on crop yields, it must be remembered that 40 to 50 years ago the practice of summer fallowing the land once every three or four years was extensively followed in the Willamette Valley on both the clay and silt loam types of soil; that this practice is still generally followed on the clay soil, but has almost disappeared on the silt loam soil. Table XIII shows the comparative yields of potatoes, wheat, oats, and hay on both the clay and silt loam farms with and without summer fallow.

TABLE XIII.—*Relation of summer fallow to crop yields on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Item.	Salem clay.		Salem silt loam.	
	Without summer fallow.	With summer fallow.	Without summer fallow.	With summer fallow.
Number of farms	11	57	127	17
Crop yields per acre:				
Potatoes (bushels)	177.8	192.6	155.9	98.4
Wheat (bushels)	23.9	25.3	21.9	23.5
Oats (bushels)	27.0	31.2	37.9	36.5
Hay (tons)	1.87	2.04	1.94	1.76
Crop index	90	101	101	96

From Table XIII it will be noted that 57 of the 68 clay farms had more or less tillable land lying idle as summer fallow, and that only 17 of the 144 silt-loam farms were still practicing the summer-fallow method. The clay farms having summer fallow had higher crop yields than the clay farms having no summer fallow, the relative crop index of the groups with and without summer fallow being 101 and 90, respectively. On the other hand, the silt loam farms having no summer fallow had higher crop yields, for all crops except wheat, than the few farms practicing summer fallowing. Because wheat follows summer fallow, its yield should be affected by summer fallow more than the yield of any other crop. The crop index of the silt loam farms having no summer fallow was 101, whereas that of the 17 farms with summer fallow was 96.

It appears, therefore, that on the silt loam farms having no summer fallow, cropping systems have been adopted that give higher crop yields than are secured on the 17 farms still practicing summer fallowing. This has been accomplished, it is safe to say, by the introduction of the leguminous crops. It is reasonably certain that

clover and other legumes would do as much for the clay-soil farms; for farmers who have been growing clover for a number of years on the clay soil claim that they are getting increased yields.

BARNYARD MANURE AND DRAINAGE.

There are other ways of increasing crop yields besides those brought out by the survey data, among which may be mentioned the use of barnyard manure and drainage. It is a well-recognized principle in agriculture that crop yields on almost any type of soil may be increased by a more liberal use of barnyard manure. Especially is this method of increasing crop yields applicable where the soil has been receiving little animal or vegetable manure. The farmer who adopts this method must see to it that the live stock kept are high-producing animals. He must also use good judgment in marketing his live stock and live-stock products. If this is not done, he may increase his crop yields without increasing his profits.

Much of the agricultural land of the Willamette Valley is so low and level that it is water-logged during much of the time in winter. There probably is no other way by which crop yields on such land can be increased as easily as by drainage. In some localities the individual farm can be drained independently. In other localities the land is so level that it will be necessary to organize drainage districts and work cooperatively in order to get an outlet for the water.

RELATION OF SOIL TYPE TO PERCENTAGE FARM INCOME IS OF CAPITAL.

Table XIV shows the comparative percentages farm income is of capital on the two major types of soil found in the valley. On the 68 clay farms, it will be seen, farm income was 4.35 per cent of the capital invested, as compared with 6.64 per cent on the 144 silt loam farms. That is to say, the silt loam farms were operated 1.52 times as efficiently as the clay farms. The question naturally arises as to the cause of this difference.

TABLE XIV.—*Relation of type of soil to percentage farm income is of capital, on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Item.	Salem clay.	Salem silt loam.
Number of farms	68	144
Average area of improved land	185	128.5
Average capital invested	$25,330	$21,457
Average farm income	$1,103	$1,425
Percentage farm income is of capital	4.35	6.64

From Table XIV it will be observed that the clay farms had 56.5 more acres of improved land and $3,873 more capital to use than had the silt loam farms. Therefore, the difference in the efficiency

of these farms was not due to the lack of capital or usable land on the part of the clay farms. Neither was it due to the difference in the valuation of real estate on the two types of soil, for Table I shows land was worth $89 per acre on the clay farms and $112 on the silt loam farms.

CAUSES OF THE DIFFERENCE IN EFFICIENCY.

(1) An average of 73.6 per cent of the farm area of the silt loam farm, as shown by Table I, was improved land, as compared with 71.2 per cent for the clay farms. Thus the silt loam farms have available a slightly higher percentage of improved land.

(2) The silt loam farms produced clover seed, whereas the clay farms produced none. As shown in Table VIII, clover seed in 1912 was a very profitable crop. This contributed materially to the difference in the efficiency of the farms on the two types of soil.

TABLE XV.—*Relation of types of soil to income per productive animal unit and to crop yield on 212 farms in Marion and Polk Counties, Oreg. (1912).*

Item.	Salem clay.	Salem silt loam.
Number of farms	68	144
Average income per productive animal unit per farm	$51	$55
Average productive animal units per farm	13.87	13.19
Crop yields per acre:		
Potatoes (bushels)	187.7	150.2
Oats (bushels)	30.8	37.7
Wheat (bushels)	25.2	22.0
Hay (tons)	2.0	1.9
Crop index [a]	96	102

[a] Crop index of this table is based upon the 212 records.

(3) Table XV shows the number of productive animal units per farm, the income per productive animal, and the crop yields on the two types of soil. It will be seen that the clay farms had an average of 13.87 productive animal units per farm, as compared with 13.19 for the silt loam farms; and that the income per productive animal unit was $4 greater on the silt loam farms than on the clay farms. This would give the silt loam farms an income approximately $55 per farm greater than that of the clay farms.

(4) From Table XV it will also be seen that potatoes, wheat, and hay, three of the four leading crops upon which crop index in this table is based, gave higher yields on the clay farms than on the silt loam farms. Oats, on the other hand, gave the highest yield on the silt loam farms. However, the crop index of the clay farms was 96 as compared with 102 for the silt loam farms. The difference in the yield of oats on the two types of soil and the large percentage of the rotation area devoted to that crop (see fig. 1) are the causes of the clay farms having the lower crop index. Hence, the difference in the percentage farm income is of capital on the two types of soil

may be attributed, at least in part, to the low yield and large acreage of the oat crop on the clay farms.

(5) Perhaps the greatest cause of the lower efficiency of the clay farms is the practice of summer fallowing approximately one-fourth of the rotation area each year. During the year 1912, 24.5 per cent of the rotation area on the clay farms lay idle as summer fallow, as compared with 2.7 per cent on the silt loam farms (see fig. 1). The practice of summer fallowing diminishes net receipts in two ways. In the first place, the land being summer fallowed represents idle capital from which there is no return. Secondly, the cultivation of the idle land during the summer-fallow year materially increases the operating expenses. On the clay farms 46.1 per cent of the gross receipts were required for operating expenses as against 37.7 per cent on the silt loam farms. The work of cultivating the summer fallow is very largely responsible for this difference.

STARTING CLOVER ON THE CLAY SOIL.

From what has been said in this discussion it should be evident that the profitableness of farming on the clay soil can be greatly increased by adopting cropping systems or rotations that will do away with the summer-fallow practice, and in which clover and other leguminous crops will have a prominent place. Until very recently a very large percentage of the farmers on the clay soil thought this was not feasible. During the last few years, however, many attempts have been made to grow clover on the clay soil. During the season of 1916 a detailed study of 53 trials of growing clover was made in order to determine (1) whether clover can be successfully grown on this type of soil and (2) the most practical ways of getting a stand. The success of the 53 trials, which included 1,111 acres, is shown in Table XVI.

TABLE XVI.—*Results of seeding clover alone and with different nurse crops on Salem clay soil, Marion County, Oreg.*

Nurse crop.	Time of clover seeding.	Number of trials.	Total acres seeded.	Percentage of cases in which the stand was—		
				Good.	Poor.	Failure.
Spring oats	Feb., Mar., Apr.	19	392	81.9	10.5	7.6
Spring barley	do	1	18	100	.....	.....
Spring wheat	do	4	87	100	.....	.....
Winter wheat	do	13	202	85.7	11.4	3.0
Do	Fall	2	70	14.3	.....	85.7
Winter oats	March	5	107	81.8	7.5	10.7
No nurse crop, clover sown alone	May-June	9	235	100.0	.....	.....
Total	.....	53	1,111	83.8	6.5	9.7

It will be noted that a good stand was secured on 931 acres of the 1,111 acres seeded. In other words, 83.8 per cent of the area seeded gave satisfactory results. A good stand was secured on 100 per cent of the area seeded alone late in May or early in June. A good stand

was also secured on 100 per cent of the area seeded with spring barley and spring wheat. While the number of trials with these two crops is too small to draw very reliable conclusions, studies of starting clover elsewhere show that barley is one of the most satisfactory nurse crops.

The results secured by seeding clover in the spring with spring oats, winter oats, and winter wheat are all that should be expected. The two trials of seeding clover in the fall with winter wheat strongly indicate that that method is unsatisfactory.

METHODS.

From a study of Table XVI three practical methods of starting clover on the clay soil are suggested: (1) Sown alone late in May or early in June; (2) sown with spring grain in the early spring; and (3) sown with winter wheat in the early spring.

1. *Seeding clover alone.*—For seeding clover alone in the late spring the land is plowed quite deep during the winter and kept thoroughly cultivated from early spring until seeding time. About 8 pounds of red-clover seed per acre are sown alone as soon after the 15th of May as weather conditions will permit. The seed is sown broadcast and covered with a harrow or corrugated roller. This is probably the surest method of getting a stand. It should be used only on land that never grew clover before, because the use of the land is practically lost during the year the clover is seeded. Some farmers sow about 5 pounds of rape seed per acre with the clover. The rape makes good sheep, hog, or calf pasture in about six weeks after seeding.

2. *Seeding clover with spring grain.*—When clover is seeded in the early spring with barley, wheat, or oats the land is plowed during the fall or winter and a good, firm, mellow seed bed prepared in the early spring. Eight pounds of red-clover seed per acre are sown late in February or early in March immediately after the grain. The seed is covered with the harrow or corrugated roller, preferably with the roller, as it packs the soil.

3. *Seeding clover in the spring with winter wheat.*—When starting clover with winter wheat about 8 to 10 pounds of seed per acre are sown broadcast late in February or early in March. If wheat has made sufficient growth it is an excellent plan to pasture the field off quickly with sheep. The tramping of the sheep covers the clover seed and packs the ground. After removing the sheep, the field is harrowed to loosen the surface. If no sheep are available, the seed is covered with the harrow.

In starting clover by either of the above methods on land that never produced the crop before, the soil should be as free as possible from weeds. For this reason winter wheat grown on land that was well summer fallowed the previous season makes a good nurse crop. Clover requires a firm, compact seed bed. The corrugated roller is

an excellent implement with which to prepare the seed bed when seeding clover with spring grain. The application of barnyard manure practically insures a stand of clover. The manure should be applied in the fall or winter and plowed under or worked into the soil with a disk harrow.

Inoculation.—The nodule-forming bacteria, that is, the organisms which enable the clover to utilize atmospheric nitrogen, are so essential to the success of clover that land which has never produced this crop should be inoculated. The land to be seeded may be inoculated in two ways; by using a pure culture, or by using soil from a field that successfully produced clover the previous year. The pure culture may be obtained in limited quantities from the United States Department of Agriculture or bought in large quantities from commercial concerns. Directions for use are sent with the cultures.

Inoculation by the soil method should be performed as follows: Locate a patch of clover that grew thriftily the previous year. It may be necessary to go to some farm on the silt loam soil to find it. Collect soil from about plants which bear nodules on their roots. About 1 quart of this soil is placed in a bucket of water and thoroughly stirred. The clover seed is placed upon a tight floor, dampened with the muddy water, using about 2 quarts to each bushel of seed, and shoveled over several times to be sure that each seed is dampened. After the seed has been allowed to dry in the shade (sunlight kills the bacteria) it is ready for seeding. The addition of one-fourth of a pound of glue to each gallon of water will cause the soil to stick to the clover seed.[1]

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[1] Very similar methods of seeding clover in the Willamette Valley, Oreg., have been published in Farmers' Bulletin 271, "Forage Crop Practices in Western Oregon and Western Washington," and in Bureau of Plant Industry Circular 28, "Clover Seed Production in the Willamette Valley, Oregon."

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